MICHIGAN
DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION
FOR
TRAFFIC SIGNAL WIRELESS COMMUNICATIONS LINK

SIG:EMS   1 of 6   APPR:NJB:HLO:03-27-23
                                                           FHWA:APPR:03-28-23

a. Description. This work consists of completing one or more of the following work types at locations shown on the plans:

1. Performing site evaluation and furnishing, installing, integrating, and testing a wireless communications link at locations designated on the plans. Wireless communications links will consist of all cabling, radios, antennas, and the system appurtenances required to complete a functional link. Perform this work in accordance with the standard specifications, except as modified herein.

2. Removing and disposing of an existing wireless communications link.

3. Removing, storing, and reinstalling an existing wireless communications link.

b. Materials.

1. Traffic signal wireless communications link. Furnish a traffic signal wireless communications link from the following list.

A. Encom Broadband Radio

B. Approved equal (AE). Ensure the AE is evaluated, tested, and approved per the MDOT New Traffic Signal Device Product Review Guidelines. The review time is not justification to delay the project.

2. Furnish wireless link equipment including a transmitter, receiver, antenna, cabling, patch cords and jumpers, surge suppressors and lightning protection, attenuators, splitters, amplifiers, and power supply.

A. Ensure installed field equipment can operate in all weather conditions, as applicable within Michigan.

B. Use interoperable and interchangeable equipment at each field location.

C. Supply all equipment required for the configuration and testing of devices and sub-systems contained in this project as an appurtenance to the equipment included in the project and at no additional cost to the contract.

3. Minimum technical requirements for Wireless Link radios.

A. Technology Solutions. Line of Sight (LOS) wireless technologies, n/NLOS wireless technologies where wireless paths are obstructed - orthogonal frequency division

multiplexing (OFDM), multiple-input multiple-output (MIMO) or other compatible n/NLOS wireless technologies.

B. Security Configurations. Authentication, IP Address/Media Access Control (MAC) Address Filtering.

C. Network Connection Types. 10/100Base-TX; 1000Base-T where Gigabit Ethernet is required as shown on the plans.

D. Intelligent packet filtering by network address, protocol, or packet content.

E. Simple network management protocol (SNMP) compliance. Management information base (MIB)-I, MIB-II.

F. IEEE Standards: 802.3 Ethernet, 802.1p Bridging Mode, 802.1Q Virtual Local Area Network (VLAN).

G. Remote Configuration. Wired or wireless local area network (LAN) station telnet, file transfer protocol (FTP), or hypertext markup language (HTML) via web browser.

H. Packet Routing. Store and forward capability required where error checking and error correction features and functions are not an option of the submitted equipment.

I. Error Checking. Cycle redundancy check (CRC) 32 Bit and package protocol acknowledgment.

J. Error Correction. Forward error correction (FEC), automatic repeat request (ARQ).

K. Network Topology. Point-to-point (PTP) and Point-to-multi-point (PTMP) configurations are required as shown on the plans.

L. Configuration and Network Management. Ensure the radio system is furnished with a network visualization and management software that allows for configuration and diagnostics of the entire wireless network. The software package must allow the operator to communicate with all similar radios in the system including 900 megahertz (MHz), 2.4 Gigahertz (GHz), 4.9Ghz and 5.8GHz Ethernet radios and serial data radios. Ensure the following features are present within the software:

(1) Complete configuration tool:

(a) Includes comprehensive context-sensitive online help;

(b) Profile based configuration with the most common configuration supplied with the software;

(c) Configuration assistance tools to detect any error on the fly;

(d) Profile import/export tools allow user to easily copy configuration from radio to radio;

(e) Supports configuration of quality of service (QoS), VLAN, firewall and port forwarding;

(f) Automatically displays comprehensive radio configuration and status information when a radio is selected.

(2) Monitoring:

(a) Built-in mapping system uses freely available maps to help visualize the location of the radios and the topology of the radio network;

(b) Use only free open source mapping engine with no ongoing cost to end user;

(c) Mapping system has an off-line mode for use with a laptop without internet connection;

(d) A simple map icon indicates the radio location, online/offline status, signal level, wireless link rates and their performance, that are all updated in real time;

(e) Network Traffic Monitoring Tools.

(3) Diagnostics:

(a) High resolution software spectrum analyzer helps the user select the wireless channel that has the least interference;

(b) Antenna alignment tools with graphical signal level display and signal sensitive audio tone available;

(c) Antenna alignment tools support per connection and per-chain alignment (for wireless-N radios);

(d) Comprehensive bandwidth test tools to identify bottlenecks in the network;

(e) Ping test tools to verify the performance of the network.

(4) Alarm reporting:

(a) User configurable alarm settings such as:

(i) Online/offline status;

(ii) Receive signal level drops;

(iii) Connection quality drops; and

(iv) Data rate drops.

(b) Alarms are logged and optionally e-mailed to any number of recipients.

(5) Licensing:

(a) No software licensing registration or fees required;

(b) No ongoing map functionality costs;

(c) Can install on any number of laptops or workstations; and

(d) Ensure web browser interface is also available to configure the radios.

M. LED Indication. Ensure all radios include visual indication for power and signal strength.

N. Radio Options. Where shown on the plans the selected radio platform must include options for:

(1) A secondary Ethernet port that can be used as a power over Ethernet (POE) output;

(2) An audio port used for aligning the antenna;

(3) A reset to default button; and

(4) A dual radio option that contains two transmitters in one platform.

4.   Functional Requirements.

A. Furnish radios capable of operating in Near-Line of Sight (nLOS) and Non-Line of Sight (NLOS) environments where wireless path obstructions are present. n/NLOS radios and antennas are to support OFDM, MIMO and/or other applications, features and technologies that are suitable for n/NLOS radios and antennas.

B. Furnish 2.4GHz, 4.9GHz or 5GHz radios with a minimum data rate of 54 Megabits per second (Mbps) and capable of transmitting and receiving at distances shown on the plans.

C. Furnish radios capable of being asymmetrically adjusted to enhance bandwidth. Furnish wireless link software that enables configuration up and downstream link splits to accommodate bandwidth needs.

D. Furnish a minimum link availability of 99.9 percent over the specified distance.

E. Furnish a password protected network management software (NMS) or configure the radio's web browser interface allowing for the remote configuration of the wireless link and the ability for remote software/firmware updates.

F. Furnish radios capable of using the required number of non-overlapping channels to communicate with all radios communicating with it.

G. Furnish radios with dynamic and manual selection of available channels. The capability of locking in radio channels manually (in either direction) and restricting each segment to specified channels is required.

H. Mutual security authentication and support for data encryption system (DES) or advanced encryption system (AES) encryption and authentication via remote

authentication dial-in user service (RADIUS) is required for the wireless link.

    I. Ensure the wireless link is fully interoperable with any existing signal communications network.

    J. Ensure each unit is software configurable to work as a master, remote, mesh node, hotspot or repeater. It is not acceptable to have different units for each mode of operation.

    K. Ensure all mounting hardware for the radios and antennas, including Category 5e or better industrial outdoor rated cable is included as shown on the plans.

    L. Ensure the radios specified are capable of over the air firmware upgrades.

  c. Construction. Complete this work in accordance with sections 818 and 820 of the Standard Specifications for Construction, as shown on the plans and as directed by the Engineer.

    1. Installation.

    A. Furnish the Engineer 10 days advanced notice of planned date of installation for the wireless links. Obtain the Engineer's approval prior to beginning antenna installation. Coordinate installation with MDOT electrician. Install the radio antennas after the rest of the signal equipment (signal heads, poles, case signs, span wire, etc.) has been installed.

    B. Adjust mounting and orientation of antennas as required during the testing process performed by the MDOT electrician. Reorient or move radio antenna installations that were completed prior to the approval of the Engineer, and which are found to be non-optimal placement of the antennas at no additional cost to the contract. The Engineer will not authorize extra payment or time extensions for work required to reorient or move the radio antenna.

    C. Wiring Requirements. Cut all wires to proper length before assembly with no wire doubled-back to take up slack. Furnish cabling laced with nylon and plastic straps and secured with clamps. Furnish service loops at all connection points.

    D. Local Device Assembly Test (LDAT).

      (1) Verify physical construction has been completed per the contract.

      (2) Inspect the quality and tightness of ground connections.

      (3) Verify the radio has been configured with the proper site name, IP address, subnet mask, gateway, and VLAN settings.

      (4) Verify actual throughput meets requirements using two laptops with Iperf, Jperf, or similar approved software. Verify wireless links maintained a minimum actual measured data throughput of 10 Mbps for 10 minutes duration.

      (5) Record the throughput, signal-to-noise ratio (SNR), received signal strength (RSS), and noise level.

    E. Furnish and install the wireless link, IP, master or remote as shown on the plans.

2. Documentation Required.

A. Furnish complete and detailed cut-sheets on all equipment.

(1) Include equipment/parts list, schematic diagrams, antenna selection, radio equipment, communication equipment and cabling, equipment rack layouts, and device connection/protocol information.

(2) Present a list of tools and test equipment (common and specialized, and including any built-in testing facilities that are functionally equivalent to external test equipment) necessary to install, operate, test, and maintain all equipment proposed in this project.

B. Furnish any exportable electronic configuration files for each Wireless Link, Master and Remote. The file will contain the location of the wireless link, its serial number, and final accepted configuration, and will be named to clearly indicate the device location from which it was obtained.

C. Warranty. Furnish warranty and other applicable documents from the manufacturer, and a copy of the invoice showing the date of shipment, to the Engineer prior to final written acceptance. Furnish the wireless link with a standard manufacturer's warranty, transferable to MDOT. The wireless link must carry a warranty (parts, software and labor) of 1 year from the date of shipment.

3. Maintain all equipment through final acceptance, including, but not limited to, furnishing and installing all available software/firmware upgrades.

d. Measurement and Payment. The completed work, as described, will be measured and paid for at the contract unit price using the following pay items:

Pay Item	**Pay Unit**
TS, Wireless Link, (frequency), (type)	Each
TS, Wireless Link, Rem	Each
TS, Wireless Link, Salv	Each

1. **TS, Wireless Link, (frequency), Master** includes evaluating, procuring, constructing, and verify testing of a master radio.

2. **TS, Wireless Link, (frequency), Remote** includes evaluating, procuring, constructing, and verify testing of a remote radio.

3. **TS, Wireless Link, Rem** includes removing and storing or disposing of an existing traffic signal wireless link at the location(s) shown on the plans.

4. **TS, Wireless Link, Salv** includes reinstalling a removed traffic signal wireless link at the location(s) shown on the plans.